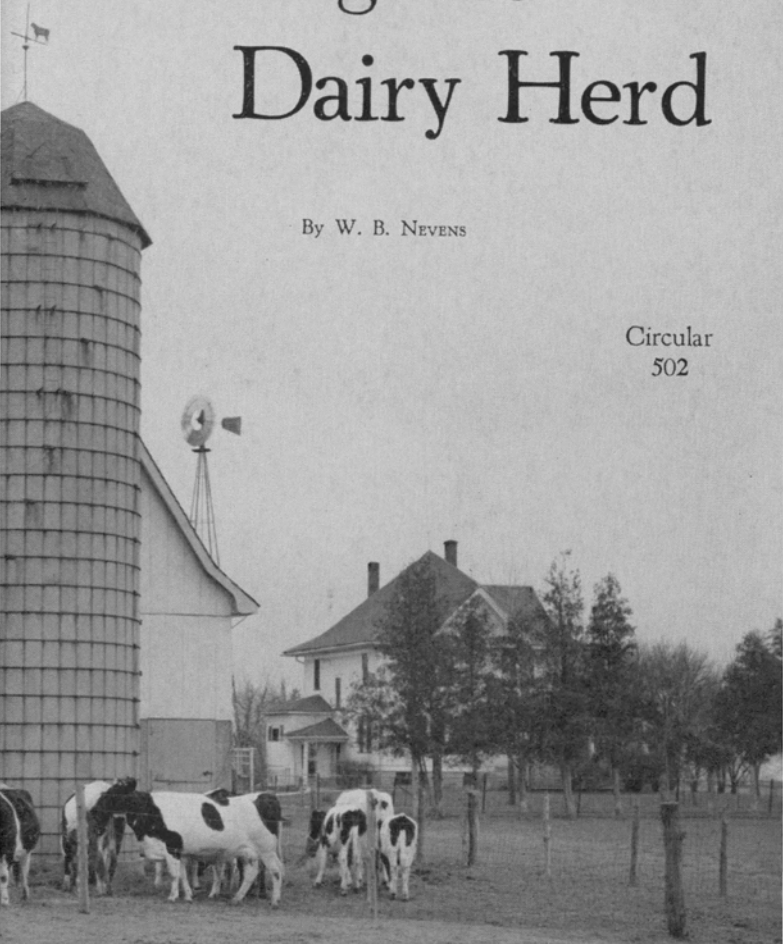
Feeding the Dairy Herd

By W. B. Nevens

Circular
502



UNIVERSITY OF ILLINOIS • COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION AND EXTENSION
SERVICE IN AGRICULTURE AND HOME ECONOMICS

Do YOU make these common mistakes in feeding your dairy cows:

- Feeding too little good-quality roughage ?
- Providing not enough protein ?
- Feeding too much or not enough grain in proportion to milk production ?

Many farmers do, without being aware of the losses they incur thereby. This booklet tells how to avoid such mistakes and others. It is cut to pocket size and fitted with a sturdy cover so that it may be kept in the pocket for handy reference as questions about feeds and feeding arise.

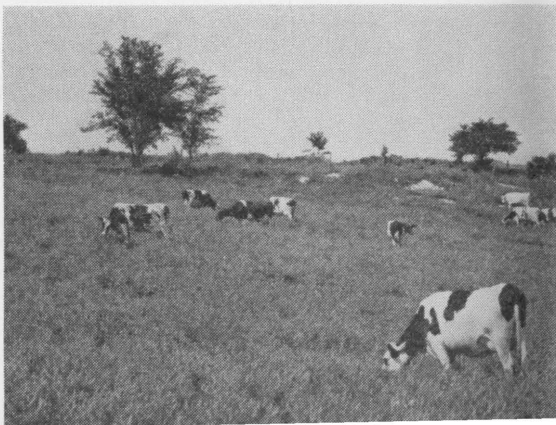
Urbana, Illinois
February, 1940

Revision of Circular 440 of same title

CONTENTS

Alfalfa hay for winter feeding

Legume hay in the winter and legume or part-legume pasture during the grazing season offer the best foundation for good dairy rations. Properly balanced grain mixtures fed in proportion to production are also needed if cows are to produce large quantities of milk.



Sweet clover pasture in July

Feeding the Dairy Herd

By W. B. Nevens, Chief in Dairy Cattle Feeding

A GOOD JOB of feeding dairy cows means simply striking the right adjustment between *cost of feeds* and *volume of milk production* so that the difference between costs and gross returns will be as much as possible. That does not mean necessarily that the cost of the feed should be held to the lowest figure possible. Nor does it mean on the other hand that the cows should always be fed so as to get from them the utmost possible quantities of milk. It does mean, as a rule, the feeding of a well-balanced assortment of feeds, most of which are home-grown, to carefully selected cows, so that there will be a high yield of milk from each cow.

It costs a little more to feed high-producing cows than to feed low producers. But in general the difference in cost is small compared with the difference in returns. Year in and year out the secret of successful dairying is to get large amounts of milk from a few cows—and the secret of that is to cull out the low producers, to feed good cows well, and to breed for high production.

High-Producing Cows Most Profitable

Butterfat per cow	Feed cost per cow[a] yearly	Feed cost per pound butterfat	Value of butterfat above feed cost, yearly	
			At 25¢ a pound	At 35¢ a pound
lbs.				
200	$55	$.28	$−5 (loss)	$15
300	64	.21	11	41
400	73	.18	27	67
500	84	.17	41	91

[a]Costs based on records of cows enrolled in Dairy Herd Improvement Associations in Illinois during ten years, 1929-1938.

QUALITIES OF A GOOD DAIRY RATION

In making up a ration for dairy cows, the following ten characteristics are the qualities to strive for. Of all the feeds, young pasture grass comes nearest to meeting all the requirements. Winter rations should therefore be made up of a mixture of feeds which will have, as a whole, as many of the following ten characteristics as possible.

Appetizing. Nearly all the usual feeds are appetizing if they are of good quality. Variety adds to the palatability.

Varied. A ration composed of several suitable feeds is more likely to be palatable and adequate in kinds and amounts of nutrients than one composed of one or two feeds.

Succulent. Silage, root crops, and pasture grasses stimulate the appetite, in addition to their other feed values.

Adequate in protein. Cows cannot give high yields of milk on low-protein feeds.

Highly digestible. Even when finely ground, the coarse parts of cornstalks, soybean and Sudan-grass hay, and corncobs have very little nutritive value.

Not too bulky. Corncobs or other woody roughages ground in the grain mixture limit the amount of more nutritive feed that can be eaten, and are of doubtful value.

Slightly laxative. Legume hays, linseed meal, wheat bran, molasses, and the succulent feeds and grasses have a slightly laxative effect.

Wholesome. Moldy, heated, or fermented feeds, or newly made hay and silage, often cause cows to go off feed, or cause serious illness. Sudden changing of feeds may cause indigestion, diarrhea, and bad flavors in the milk.

Conducive to good milk flavor. Corn or legume silage, turnips, cabbage, rape, wild garlic, wild onions, ragweeds, and sweet clover or rye pasture should not be eaten by milk cows within 6 to 8 hours before milking. Silage should be fed just after milking.

Economical. Prices of feeds change, and it is therefore profitable to figure relative costs.

SIMPLE CLASSIFICATION OF FEEDS TO AID IN SELECTING A RATION

Palatable Feeds

Roughages	*Concentrates*	*Concentrates*
Corn silage	Barley	Oats
Legume hays, in good condition	Beet pulp	Linseed meal
	Corn	Molasses
Roots and tubers	Corn gluten feed	Soybean oilmeal
Fresh green roughages	Corn gluten meal	Wheat bran
	Hominy feed	

Laxative Feeds

Roughages	*Concentrates*	*Concentrates*
Corn silage	Flaxseed meal	Soybeans
Legume hays and silage	Linseed meal	Soybean oilmeal
Roots and tubers	Molasses	Wheat bran
Fresh green roughages		

Constipating Feeds

Roughages	*Concentrates*
Corn stover	Corn
Most hays except legumes	Sweet sorghum cane seed
Straws from the cereal grains	

BARN FEEDING

Roughage Is the Basis

Best results in dairy feeding usually come when the main emphasis is put on feeding large amounts and a good variety of the best roughages rather than on feeding large amounts of grain. But even so, high-producing cows cannot do their best on roughage alone. To produce large amounts of milk they must have grain in addition, for such cows cannot eat enough bulky feed to supply all the nutrients they need.

Feed hay liberally. Cows in milk should have all the good-quality hay they will consume without undue waste. If the hay is coarse, such as first-cutting alfalfa, it should

Except during cold stormy weather, cows will eat more hay if part of it is fed outdoors. Corn stover and coarse or dusty hays are as a rule eaten better outdoors in suitable racks than in the barn. Also for the feeding of roughage when pastures are poor, or the feeding to heifers and dry cows of hay which the cows in milk have picked over, outdoor racks are excellent.

be fed liberally and the refused portions given to dry cows, yearling heifers, or horses to pick over. Horses, particularly, make good use of the coarse stems that are left from well-cured but coarse hay.

More hay will be eaten if it is fed three times a day than if fed only once or twice—and the more good-quality hay the cows eat, the better. Also, if cows have plenty of water that is not too cold, they will eat more hay than if they are thirsty.

Variety whets the appetite. When two or more kinds of hay are available, variety may be obtained by feeding more than one kind each day. This tends to keep the appetites of the cattle keener than when one kind of hay is fed continuously.

Corn silage an excellent supplement. Corn silage makes an excellent supplement to hay, but should not be fed as the only roughage nor to take the place of a grain supplement.

Good-quality corn silage is usually fed at the rate of about 3 pounds daily for each 100 pounds of animal weight, or 25 to 40 pounds daily. In no case should so much corn

silage be fed that it prevents the animals from eating hay freely. It usually is fed twice daily, placed in the manger first and the grain mixture thrown on it. Silage having a strong odor, however, should be fed only after milking.

If other kinds of silage are used they should be fed in the same manner as corn silage, tho not necessarily at the same rate (*see page 30*).

What Kind and How Much Grain Mixture?

The kind and amount of grain mixture to feed depends on (1) the kind and quality of roughage the cows are getting; (2) the amount of milk each cow gives, taking into account the stage of the lactation period; and (3) the relative costs of the different feeds that may be used in the mixture.

In choosing a mixture to fit the roughage, the first consideration is, How much protein should the mixture contain? And the second is, What combination of appetizing feeds having the right amount of protein will be cheapest? In general, the more nearly the roughage is all-legume and the higher its quality, the lower the amount of protein needed in the grain mixture. And the more milk a cow gives, the more grain she should receive.

Formulas for grain mixtures to be fed with different kinds of roughage are listed on pages 10 to 12, and a method for calculating costs of mixtures is described on page 19.

Study Each Cow's Needs

Best results can be gained by studying each cow's needs and habits carefully and then making the proper adjustments in amounts of grain or of roughage. Some cows eat more hay than the average and so need less grain. Others eat less hay and need more grain.

In any case it seldom pays to feed a cow more than 16 pounds of grain mixture a day. When larger amounts are fed, there is danger of throwing the cow off feed and

greatly reducing her production of milk for several days or even several weeks. Only persons especially skilful in feeding dairy cows should attempt heavy grain feeding.

Measure the Grain for Each Cow

A good job of feeding a dairy herd is impossible unless both the milk produced and the grain fed to each cow are carefully weighed. To feed more than is necessary is a waste; but to feed a good cow less than she can make good use of is just as unprofitable. Weighing or otherwise carefully measuring tne grain for each cow each time she is fed is thus one of the most important of all operations in the management of a dairy herd.

Weigh the milk produced by each cow during one day at least once each week, and feed grain according to the production. (*See the guides to feeding grain mixtures, pages 9 and 16.*) The best way is to make a chart showing the number of pounds or quarts of grain mixture each cow should receive at each feeding, and to consult the chart each time the grain mixture is weighed or measured. The chart should be changed each week or as often as the milk yields of the cows change appreciably. A sample chart, showing a convenient arrangement, is given below.

SAMPLE FEEDING CHART

*For week ending*_____

Cow (name or No.)	Pounds of milk daily	Pounds of grain mixture	
		Daily	Each feeding
1	35	10	5
2	28	8	4
3	39	11	5.5
4	50	14	7
5	21	6	3

Provide for Comfort of the Herd

The feeds provided are not the whole story in caring for a dairy herd in winter. Comfortable clean quarters, plenty of bedding, plenty of water not too cold to drink, regularity of feeding and milking, and kind treatment in general are management practices that go along with a good feeding program. Cows giving milk should not be turned out of the barn to stand around for several hours on cold windy days. Nor should they be required to drink ice-water. A tank water-heater is a good investment for any dairyman who does not have a water system in the barn. The cows should be watered at least twice a day.

BARN FEEDING: A GUIDE TO FEEDING THE GRAIN MIXTURES

Mixture fed *(see pages 10 to 12)*, and breed of cattle	AMOUNTS OF GRAIN TO FEED DAILY	
	When roughage is fed *liberally* (all that the cows will eat without undue waste)	When roughage is fed in *moderate amounts*
About 13 percent protein (Mixtures 1-6)		
Ayrshire, Holstein, Swiss	1 lb. grain to *3.5 lb. milk*	1 lb. grain to *3 lb. milk*
Guernsey, Jersey	1 lb. grain to *3 lb. milk*	1 lb. grain to *2.5 lb. milk*
About 15 percent protein (Mixtures 7-12)		
Ayrshire, Holstein, Swiss	1 lb. grain to *4 lb. milk*	1 lb. grain to *3.5 lb. milk*
Guernsey, Jersey	1 lb. grain to *3.5 lb. milk*	1 lb. grain to *3 lb. milk*
About 18 percent protein (Mixtures 13-18)		
Ayrshire, Holstein, Swiss	1 lb. grain to *4 lb. milk*	1 lb. grain to *3.5 lb. milk*
Guernsey, Jersey	1 lb. grain to *3.5 lb. milk*	1 lb. grain to *3 lb. milk*

If the milk is not weighed but is measured in gallons, the weight may be computed by multiplying the number of gallons produced daily by 8.6, the number of pounds per gallon. Weighing is usually more accurate, however, than measuring in gallons.

GRAIN MIXTURES

The mixtures shown here are planned on three levels of total protein, to be used according to the quality and kind of roughage being fed. Choose a mixture to supplement the roughage you are feeding.

About 13 Percent Total Protein

Feed a grain mixture having about 13 percent total protein if you are feeding hay or silage made entirely from legumes (alfalfa, clover, lespedeza, soybeans, cowpeas), or if the cows are on pasture that is making a vigorous new growth either in spring, late summer, or fall. If corn silage, corn stover, or any other nonlegume roughage is fed, the grain mixture should contain more protein than any of these on this page will provide.

No. 1

	lb.
Ground soybeans or linseed meal	100
Ground corn	585
Ground oats	300
Salt	15

No. 2

	lb.
Ground soybeans or linseed meal	100
Wheat bran	200
Ground corn	685
Salt	15

No. 3

	lb.
Ground soybeans or linseed meal	75
Wheat bran	200
Ground corn	400
Ground oats	310
Salt	15

No. 4

	lb.
Soybean oilmeal or cotton-seed meal	75
Ground corn	500
Ground oats	410
Salt	15

No. 5

	lb.
Soybean oilmeal or cotton-seed meal	75
Wheat bran	300
Ground corn	610
Salt	15

No. 6

	lb.
Wheat bran	300
Ground corn	350
Ground oats	335
Salt	15

Note.—In addition to the substitutions indicated in the foregoing formulas, ground barley or ground wheat may be substituted pound for pound for ground oats or ground corn. The ground corn may be either shelled-corn meal or corn-and-cob meal. The use of two or more farm grains in each mixture is recommended. Ground soybeans are not recommended if soybean hay is fed, unless the hay is cut before the seed is well developed.

About 15 Percent Total Protein

Feed a grain mixture having about 15 percent total protein if you are feeding part legume and part nonlegume hay, or legume hay and corn silage or stover, or if the cows are on pasture that is past the bloom stage but not fully ripened.

No. 7

	lb.
Ground soybeans or linseed meal	200
Ground corn	450
Ground oats	335
Salt	15

No. 8

	lb.
Ground soybeans or linseed meal	200
Wheat bran	200
Ground corn	585
Salt	15

No. 9

	lb.
Ground soybeans or linseed meal	150
Wheat bran	300
Ground corn	300
Ground oats	235
Salt	15

No. 10

	lb.
Soybean oilmeal or mixture of soybean oilmeal and cottonseed meal	175
Ground corn	500
Ground oats	310
Salt	15

No. 11

	lb.
Soybean oilmeal or mixture of soybean oilmeal and cottonseed meal	175
Wheat bran	225
Ground corn	585
Salt	15

No. 12

	lb.
Ground soybeans or linseed meal	150
Cottonseed meal	75
Ground corn	610
Wheat bran	150
Salt	15

Note.—In addition to the substitutions indicated in the foregoing formulas, ground barley or ground wheat may be substituted pound for pound for ground oats or ground corn. The ground corn may be either shelled-corn meal or corn-and-cob meal. The use of two or more farm grains in each mixture is recommended. Ground soybeans are not recommended if soybean hay is fed, unless the hay is cut before the seed is well developed.

Many farmers overestimate the quality of the roughage they feed, and consequently do not provide enough protein in their grain mixtures. Farmers frequently say they are feeding "all-legume" hay when in reality a third to half of it consists of grasses and weeds. Such hays should be considered only *part* legume, and should be supplemented by grain mixtures containing about 15 percent protein.

About 18 Percent Total Protein

Feed a grain mixture having about 18 percent total protein if the roughage you are feeding is not at least one-half legumes, or if the cows are on fully ripened nonlegume pasture.

No. 13

	lb.
Ground soybeans or mixture of ground soybeans and linseed meal	325
Ground corn	400
Ground oats	250
Salt	15
Bonemeal	10

No. 14

	lb.
Ground soybeans or mixture of ground soybeans and linseed meal	300
Wheat bran	250
Ground corn	425
Salt	15
Bonemeal	10

No. 15

	lb.
Ground soybeans or mixture of ground soybeans and linseed meal	300
Wheat bran	150
Ground corn	300
Ground oats	225
Salt	15
Bonemeal	10

No. 16

	lb.
Soybean oilmeal or mixture of soybean oilmeal and cottonseed meal	250
Ground corn	400
Ground oats	325
Salt	15
Bonemeal	10

No. 17

	lb.
Soybean oilmeal or mixture of soybean oilmeal and cottonseed meal	250
Wheat bran	250
Ground corn	475
Salt	15
Bonemeal	10

No. 18

	lb.
Ground soybeans or mixture of ground soybeans and linseed meal	150
Soybean oilmeal or mixture of soybean oilmeal and cottonseed meal	100
Corn gluten feed or brewers' dried grains	100
Ground corn	375
Ground oats	250
Salt	15
Bonemeal	10

Note.—In addition to the substitutions indicated in the foregoing formulas, ground barley or ground wheat may be substituted pound for pound for ground oats or ground corn. The ground corn may be either shelled-corn meal or corn-and-cob meal. The use of two or more farm grains in each mixture is recommended. Ground soybeans are not recommended if soybean hay is fed, unless the hay is cut before the seed is well developed.

PASTURE FEEDING

Fresh green pasture grass is the most nearly ideal feed for dairy cows, and only the high-producing cows need a grain supplement when they are feeding on good pasture of this sort. Because the composition of the grass changes, however, more grain having higher protein content is needed as the pasture matures. Young growing grass is relatively high in both protein and water, but as the season advances the proportions of these usually decline. Rates of feeding grain to cows on pastures are given in the table on page 16.

Change to Pasture Feeding Gradually

Sudden change from dry feed to pasture may result in bloat or other digestive disturbances and cause bad flavors in the milk. To prevent such conditions, the cattle should be given their usual feed of hay, or other dry roughage or silage, and grain each morning during the first few days that they are on pasture.

Cows at pasture in summer need shade during the hot part of the day. Because they have few sweat glands, cows cannot readily adjust themselves to high temperatures.

Winter rye makes a good early pasture, two or three weeks before bluegrass is ready. At Urbana the yields of dry matter from winter rye during the three- to five-week period it is pastured have been as large as the yields from bluegrass during the entire pasture season.

When the pasture consists of legumes, such as red clover, alfalfa, or sweet clover, the cattle must not be turned in for the first time when the plants are wet from dew or rain, because of the likelihood of bloat under such conditions. Further precautions in preventing bloat in cattle pastured on these crops are to give them access to dry straw or hay kept in or near the pasture, and to leave them on the pasture continuously once they have been turned on it.

CAUTION: Sudan grass must be pastured with great care. The young shoots contain large amounts of deadly prussic acid, sufficient to kill cattle within fifteen minutes to an hour after they begin grazing on it. The older grass, however, is not only harmless but very valuable for pasture. **Therefore, do not pasture Sudan grass until it is at least 18 inches tall. Furthermore, take the stock off the pasture for three or four days at any time new growth starts after a prolonged drouth or a light frost.**

It is always best when starting to pasture Sudan grass to turn onto it first a single animal, the least valuable in the herd. If at the end of two hours the grazing animal is all right, the grass is safe for the herd. With careful handling, Sudan grass at the University farms at Urbana during a period of several years has caused no poisoning of stock.

Sudan grass and soybeans seeded together furnish a great deal of feed during the hot, dry periods of late summer and early fall. The Sudan grass and soybeans shown here were seeded in early June on the same field where winter rye (*see opposite page*) had been pastured. Winter rye, Sudan grass, and soybeans grown on the same land the same year not only give a longer pasture season than bluegrass, but furnish two to three times as much feed.

Better Pastures Needed

The pasture season should be the most profitable feeding season, both because pasture plants are the most nearly ideal feed for dairy cows and because the cows harvest the crop themselves. But as a matter of fact, because of the use of low-yielding pasture crops, and poor management of the pastures and of the cows feeding on them, many farmers find the barn feeding season more satisfactory.

In general, in order to get better yields of better-quality forage, more attention needs to be given to pasture soils, to a choice of pasture plants, to a succession of pasture crops (both permanent and rotated) thruout the season, and to grazing and management practices. Grass pastures on untillable land may be greatly improved by seeding into them alfalfa or one or more of the clovers provided the land is well drained and is properly treated with lime and phosphorus where such treatment is needed. On tillable land legume crops make superior pasture because of their long growing season and their resistance to hot, dry weather. For a discussion of pasture crops and management see *Illinois Circular 465, Pasture Improvement and Management.*

Supplement Pasture With Grain Mixture

Growing grass, being high in protein and vitamins, stimulates milk production, but contains so much water that high-producing cows cannot eat enough of it to keep in good flesh. If the cows refuse grain, take them from pasture earlier in the evening, or feed the grain in the morning after they have been on drylot all night.

PASTURE FEEDING: A GUIDE TO FEEDING THE GRAIN MIXTURES

Mixture fed (*see pages 10 to 12*) and breed of cattle	AMOUNTS OF GRAIN TO FEED DAILY		
	Spring (grass growing)	Early summer (grass maturing)	Late summer (grass ripe)
About 13 percent protein (Mixtures 1-6)			
Ayrshire, Holstein, Swiss	1 lb. grain to each *3 lb. milk over and above 30 lb.*	.....	.....
Guernsey, Jersey	1 lb. grain to each *2.5 lb. milk over 20 lb.*	.....	.....
About 15 percent protein (Mixtures 7-12)			
Ayrshire, Holstein, Swiss	.....	1 lb. grain to *3 lb. milk over and above 25 lb.*	.....
Guernsey, Jersey	.....	1 lb. grain to *2.5 lb. milk over and above 15 lb.*	.....
About 18 percent protein (Mixtures 13-18)			
Ayrshire, Holstein, Swiss	.....	.....	1 lb. grain to *3 lb. milk over and above 20 lb.*
Guernsey, Jersey	.....	.....	1 lb. grain to *2.5 lb. milk over and above 10 lb.*

If the milk is not weighed but is measured in gallons, the weight may be computed by multiplying the number of gallons produced daily by 8.6, the number of pounds per gallon. Weighing is usually more accurate, however, than measuring in gallons.

METHOD OF CALCULATING MIXTURES

Because of changes in prices of feeds from time to time, decided savings may be made occasionally by changing the grain mixture to take advantage of the cheaper feeds. Among the mixtures listed on pages 10 to 12, six choices of formulas are offered at each level of total protein, and many other suitable formulas could be devised to meet special conditions. It will pay dairy farmers therefore to give special thought to relative prices of feeds.

Computing Cost of Total Protein

A good basis for selecting the most economical protein supplement at existing prices is to compare the costs of 100 pounds of total protein in the various feeds available. Amounts of total protein in different feeds are listed on page 32.

Example: When soybean oilmeal sells at $1.90 per cwt. and corn gluten feed sells at $1.25, which is the more economical source of protein?

Price of soybean oilmeal..... $1.90 per cwt.
Total protein in 100 lb..... 41 lb.
$\frac{\$1.90}{41} \times 100 = \$4.63$, the cost of 100 pounds of protein

Price of corn gluten feed..... $1.25 per cwt.
Total protein in 100 lb..... 25 lb.
$\frac{\$1.25}{25} \times 100 = \$5.00$, the cost of 100 pounds of total protein

Soybean oilmeal at $1.90 per 100 pounds is thus a slightly cheaper source of protein than corn gluten feed at $1.25 per 100 pounds.

Computing Percentage of Total Protein

Successful feeding of grain mixtures depends in large part on the ability of the feeder to judge the quality of the roughage fed and then to make up a grain mixture which will properly supplement *that particular kind and quality*

of roughage. The following rules are helpful in determining the percentage of protein needed in the grain mixture:

1. When the roughage consists of legume hay or legume silage only (that is, when no corn silage, corn stover, or pasture is fed), the grain mixture should contain from 12 to 14 percent total protein.

2. When the roughage consists of legume hay, together with corn silage or stover, or when mixed hay alone is fed, the grain mixture should contain 14.1 to 16 percent protein.

3. When the roughage is all nonlegume, such as timothy, redtop, millet, Sudan grass, corn silage and stover, the grain mixture should contain from 16.1 to 20 percent total protein.

4. When the roughage is of excellent quality, the lower percentage of protein in each case is used, but if the roughage is weathered, has few leaves, or contains a large proportion of weeds, the higher figure should be used.

5. When the roughage is definitely known to be of high quality and is fed in unusually large amounts, the grain mixture may safely contain slightly less protein than specified in these rules.

Example: Suppose that medium-quality alfalfa hay and medium-quality corn silage, together with ear corn and oats, are on hand. With this partly legume and partly nonlegume roughage, a grain mixture containing 14 to 16 percent total protein is needed; and since the roughage is of *medium* quality, about 15 percent total protein will be right.

In planning the grain mixture to supply the needed amount of protein it is usually best to keep in mind the kinds and amounts of home-grown feed on hand and to calculate a mixture that will so far as possible use the feeds in these proportions. Thus if the amount of oats (in pounds) is only two-thirds the amount of corn (in pounds), a mixture might be made up to contain 3 parts corn to 2 parts oats.

Corn-and-cob meal and oats will not make a mixture containing 15 percent total protein, for corn-and-cob meal contains only 8 percent total protein and oats only 12 percent (*see the table on page 32*). Therefore a feed or feeds with higher percentage of protein must be added to the corn and oats. Suppose soybean oilmeal and wheat bran are added to the mixture in the following proportions:

Feed	*Amount of feed* (*lb.*)	*Total protein* *In 100 pounds of feed* (*lb.*)	*Total protein* *In amount of feed used in mixture* (*lb.*)
Corn-and-cob meal..	300	8	24
Ground oats.....	200	12	24
Wheat bran.....	200	15	30
Soybean oilmeal....	50	41	20.5
	750		98.5

$\frac{98.5}{750} \times 100 = 13.1$, the percentage of total protein in the mixture.

In order to raise the percentage of protein in the mixture to about 15 percent, more soybean oilmeal should be added. When the amount of oilmeal is increased to 100 pounds, the mixture then weighs 800 pounds and contains 119 pounds of total protein.

$$\frac{119}{800} \times 100 = 14.9 \text{ percent total protein}$$

This meets the requirements satisfactorily, as a supplement to the medium-quality part-legume roughage.

Computing the Cost of the Mixture

The cost of the mixture per ton may readily be computed according to the prevailing prices of the feeds.

If the prices were: ear corn, 56 cents a bushel; oats, 42 cents a bushel; wheat bran, $28 a ton; soybean oilmeal, $38 a ton, the cost of the mixture would be as follows:

Ear corn: $.56 ÷ 70 (lb. per bu.) × 300.....	$2.40
Oats: $.42 ÷ 32 (lb. per bu.) × 200.....	2.62
Wheat bran: $28 ÷ 2000 (lb. per ton) × 200..	2.80
Soybean oilmeal: $38 ÷ 2000 (lb. per ton) × 100	1.90
Grinding 500 lb. corn and oats @ 10¢ per cwt.	.50
Total cost for 800 lb. of mixture.....	$10.22

$\frac{\$10.22}{800} \times 2000 = \$25.55$, the cost per ton

SPECIAL CARE AT CALVING TIME

Before freshening, dairy cows should be dried up and given a 6- to 8-week rest, long enough to get them in good condition for the next milking period.

Dry cows off gradually. If a cow is giving as much as 10 or 12 pounds of milk daily, the drying-off process must be gradual in order to prevent injury to the udder. Begin by leaving part of the milk in each quarter at each milking, and by reducing the amount of feed or the amount of protein in the feed. After a few days omit one of the milkings entirely. When the cow is giving no more than 3 or 4 pounds daily she need no longer be milked.

Feed liberally while dry. To put dry cows in good condition for the next lactation period, feed a grain mixture of 200 pounds ground corn and 100 pounds ground oats at the rate of 5 to 10 pounds daily, depending on the size and condition of the cows. Feed the grain in addition to good pasture or liberal amounts of legume hay.

Use laxative feeds just before calving. A week or ten days before calving make the change to a ration having a laxative effect. Good pasture or liberal amounts of corn silage or legume hay will usually answer the purpose. But if only dry feed is given and legume hay is not available, feed one of the following mixtures at the rate of 2 to 4 pounds daily:

(1)

Ground oats	100 lb.
Wheat bran	100 lb.

(2)

Ground oats	200 lb.
Linseed meal	100 lb.

(3)

Ground oats	100 lb.
Wheat bran	100 lb.
Linseed meal	100 lb.

Warm feed and water just after calving. During the first twenty-four hours after calving, both the feed and the

drinking water should be lukewarm, and very little feed should be offered. For the next several days the drinking water should not be colder than water as it comes from a deep well.

To prepare a warm bran mash, a very suitable feed for the first day, put 3 or 4 quarts of wheat bran in a pail and pour enough boiling water over it to moisten it thoroly; then pour in enough cold water to bring to body temperature, and feed while warm.

Legume hays and corn silage or roots are especially desirable during the first few days.

Get cow back on herd mixture gradually. If the udder is badly caked, little or no grain should be fed. But on the second or third day if there are no such complications, begin feeding one of the laxative grain mixtures suggested above at the rate of 2 to 4 pounds daily, gradually substituting for it the grain mixture commonly used for the herd. Make the change to the regular mixture by subtracting ½ pound of the laxative mixture and adding ½ pound of the regular mixture the second day, 1 pound the third day, 1½ pounds the fourth day, and so on. When the substitution is complete, continue increasing the daily amount of grain by ½ pound every two or three days as long as the cow continues to respond with increased milk production, according to the rates of feeding suggested on pages 9 and 16. It may take as long as three to four weeks after calving to get high-yielding cows on full feed.

FEEDING YOUNG STOCK

Dairy calves. The first six months is the most important period of growth. A calf that is vigorous and well grown at six months is more likely to develop into a larger, better, more useful animal than one that is weak or stunted at that age. It pays, therefore, to give close attention to rearing the calves during this period, emphasizing the following points:

1. Leave calves with their mothers one to four days; then separate them and feed the calves from a pail.

2. Feed warm whole milk (body temperature) for at least three weeks, at rate of 1 pound of milk per 10 pounds weight of calf.

3. Beginning at two to three weeks of age, give calves all the good-quality legume hay they will eat, and grain at rates of not more than 2 pounds per head daily until six months of age. *(See discussion of legume hays, page 29.)*

4. If skimmilk is available, it may be gradually substituted, pound for pound, for whole milk, starting about the third week and taking one week to make the change. Skimmilk may be either fresh or prepared (1 pound dried skimmilk per 9 pounds warm water). Continue skimmilk feeding until the calves are six to 12 months old. If skimmilk is not available, a purchased or home-mixed calf meal may be substituted for whole milk after the calf is 60 to 70 days old. *(See discussion of vitamins for calves, page 24.)*

There are other general points in calf feeding and care that every dairyman should observe. For example—

Keep calves warm and dry and out of cold drafts at all times.

Supply an abundance of dry bedding. As soon after birth as possible, paint the exposed part of the navel cord with tincture of iodin or dip it in a strong solution of coal-tar disinfectant.

Wash feed pails thoroly and scald with boiling water frequently.

Have milk in uniform condition from feeding to feeding.

Weigh or carefully measure milk for each calf.

Do not overfeed.

Give milk in small amounts often.

If indigestion occurs, reduce the amount of milk to half or less and feed scalded milk or raw eggs. Study the needs of each calf.

Some dairy farmers keep young calves muzzled, except at milk-feeding time, until they are old enough to eat hay or grain. As a rule, calves are unable to digest coarse feeds until they are two weeks old at least, and the muzzles prevent them from eating hay, bedding, or refuse material

which might cause digestive disturbances or death. The muzzles also prevent the calves from sucking each other, an objectionable habit.

Heifers. Many farmers neglect dairy heifers after milk feeding is discontinued. Heifers should be encouraged to eat all the good-quality roughage possible, in order to develop feeding capacity. They need grain in addition, however, the same as cows do that are giving milk. The rate should be ⅓ to ½ pound of grain mixture daily for each 100 pounds weight of the animal.

Young bulls. Adequate care for a young bull is even more important than for a heifer, because the bull is expected to grow to larger size and to exert a greater influence on the herd as a whole.

Young bulls may be fed in much the same way as heifers, except that slightly more grain is needed for the bulls than for the heifers.

See *Illinois Circular 460, Managing the Dairy Bull.*

SOME SPECIAL PROBLEMS IN DAIRY CATTLE FEEDING

What Minerals Are Needed?

Salt. All dairy cattle except very young calves should have free access to salt. When this is not possible, salt may be included in the grain mixture at the rate of 1.5 to 2 pounds in 100 pounds of the mixture.

Lime. Good-quality legume pasture, legume silage, or legume hay, and skimmilk are the best sources of lime for dairy cattle. When legume roughages cannot be supplied, lime may be furnished in ground limestone or in bonemeal of feeding grade. These may be included in the grain mixture at the rate of 1 to 2 pounds for each 100 pounds of mixture; or, for cattle fed in drylot or at pasture, a mixture of 2 parts limestone, 2 parts bonemeal, and 1 part salt may be supplied in boxes to which the cattle have free access.

Phosphorus. Grain mixtures properly balanced with protein supplements such as wheat bran, cottonseed meal, and soybean oilmeal usually prevent phosphorus deficiencies. But in a ration that is largely roughage, that contains but small amounts of high-protein supplements, or in a ration the feeds of which are grown on soils low in phosphorus, some additional phosphorus may need to be supplied. When extra amounts of phosphorus are needed, bonemeal is a good source. Rock phosphate should not be used for this purpose.

Iodin. Additional amounts of iodin for the prevention of goiter are rarely needed by dairy cattle in Illinois, but if needed, iodin is best supplied as iodized salt fed in place of ordinary salt during the last three months of pregnancy.

Other minerals. So far as known at present, deficiencies of other mineral elements in the rations of dairy cattle do not occur in Illinois and it is therefore unnecessary to purchase mineral supplements other than those mentioned above.

How Are Vitamins Supplied?

Dairy cows well supplied with good pastures thruout the growing season and with good-quality sun-cured roughages thruout the barn-feeding part of the year are not likely to suffer from vitamin deficiencies. Next to green growing crops, legume hays that have been so carefully cured in the sun that they retain most of their leaves and much of their original green color and fragrance are the best sources of vitamins for dairy cows.

Calves fed only skimmilk, grain mixture, and hay low in green color are likely to need extra amounts of vitamin A. Also calves may need a vitamin D supplement during the winter months or during the remainder of the year also unless they are out in the sunshine for an hour or more daily. If the calves consume 2.5 pounds or more of good-quality sun-cured hay per head daily they will receive plenty of vitamin D. A feeding grade of cod-liver oil given at the

rate of 1 level teaspoonful daily per 100 pounds live weight usually provides ample amounts of both vitamins A and D.

Is Fermenting or Processing Feeds Profitable?

Several different processes for "fermenting" or "converting" feeds have been placed on the market during recent years. The general plan is to add substances such as yeast or malt, together with hot water, to either whole or ground roughages, depending upon the process used. Heat is sometimes applied to hasten the fermentation or conversion process.

Aside from the fact that coarse feeds are somewhat more completely consumed when treated in these ways, such processes have little to commend them, for they involve amounts of labor and expenditure for equipment and materials seldom warranted by the results obtained.

Is a Variety of Proteins Necessary?

Carefully conducted investigations have shown that the proteins of simple mixtures such as Nos. 1 to 18 (*pages 10 to 12*) when fed with good-quality roughages of the kinds indicated, give just as good results as mixtures containing a much greater variety of feeds. A general guide to follow in determining the adequacy of the proteins is that a ration is satisfactory when it contains feeds from four different kinds of plants, provided each plant comprises a reasonable portion of the ration.

When, however, cows are receiving 15 or more pounds of grain mixture daily (*see page 7*), there is special advantage in using grain mixtures that contain a number of different feeds, the advantage being that the appetites of the cows are better maintained.

Does Grinding Grain Increase Feed Value?

The grinding of farm grains to be fed to dairy cows usually increases the feeding value by 15 to 20 percent. For high-producing cows and very small calves the grain should be ground. For low-producing cows, older calves, and heifers, the cost of grinding the grain should be com-

pared with the increased value brought about by grinding. Protein supplements also should be purchased ground rather than in nut or pea sizes, since the ground supplements mix better with ground grains.

Is Grinding Roughage Economical?

There appears to be no advantage in grinding good-quality hay for dairy cattle, because the digestibility of the hay is not increased thereby. Grinding or chopping coarse roughages such as soybean hay and corn stover reduces the amount of refused feed as compared with the same roughage given whole, but the coarsest portions of such feeds are so low in nutritive value that the real saving may amount to not more than 5 to 8 percent of the feeding value.

Another disadvantage to grinding roughage is that the dust from ground roughage is objectionable. For one reason, it is likely to get into the milk; and for another, it may irritate the throats of the workmen. The dust is particularly objectionable in barns where high-grade milk is produced.

Should Grain and Roughage Be Ground Together?

Feeding dairy cows a mixture of grain and roughage that have been ground together is not good practice, because it makes it impossible to feed the grain in proportion to milk yields and at the same time give the cows the amounts of roughage they need.

Does Feed Cause Abortion?

When rations are very deficient in calcium, abortion sometimes occurs; but such cases are rare. Abortion is usually caused by disease germs, and there is no proof that the feeding of mineral mixtures will prevent or cure this type of abortion. Cows on good rations are fully as subject to infection from Bang's disease as cows on poor rations. (*See Illinois Circular 360, Answers to Questions Regarding Bang's Disease.*)

Is Fat Test Affected by Feed?

Improved feeding of dairy cows does not, as a rule, raise the percentage of fat in the milk. Better feeding increases the yield of milk and consequently the yield of fat, but it does not increase the test.

A cow's test ordinarily varies somewhat during the lactation period. Cows that are fat when they freshen give milk that tests considerably higher than usual for a few weeks; after that the test tends to remain about constant for several months, altho it may fluctuate slightly from day to day or from week to week as the result of weather changes or other factors. Toward the end of the lactation there is a gradual increase in the test and during the last two or three weeks a sharp rise usually occurs. The test usually is slightly higher during cold weather than during hot weather.

When market requirements demand that the test of the milk of a dairy herd which is receiving good feed and care be higher than it is, the way to improve the test is thru selection and breeding rather than thru changes in feeding practices. The culling of low-testing cows and the selection of daughters of higher testing cows for herd replacement is the way to improve the herd test.

Is Silage Essential for Profitable Production?

Tho silage is a desirable and economical feed, high milk yields can nevertheless be obtained without silage or roots, provided high-quality legume hay is fed liberally.

Feeding for High-Quality Milk

In order to produce milk of the highest quality, cows must receive liberal amounts of good-quality feeds. Best results are obtained when cows are kept in good condition thruout the year.

Minerals. Tho the amounts of most of the minerals in milk cannot be changed appreciably by changing the amounts of minerals in the feed, it is essential that the minerals be adequately supplied in the feed in order to maintain a high level of production. Most of the minerals

in the ration are furnished by the roughages—pasture, hay, and silage. Legume forages are the best source of calcium. Most of the roughages, however, are not good sources of phosphorus, which is best supplied in high-protein supplements. As a rule, roughages grown on fertile soils are much higher in mineral content than roughages grown on poorer soils.

Vitamins. The vitamins naturally present in milk also are obtained mostly from the roughages. High vitamin content of milk is maintained by feeding cows on fresh green pastures that continue their growth thruout a large part of the year, or by feeding them silage (including grass and legume silage) having a good green color, and excellent quality legume hays that have been quickly cured.

Flavor. Flavor in milk is definitely affected by feeds. Rations containing ample amounts of protein, minerals, and vitamins, and which have as their basis large amounts of green pasture crops or well-cured roughages high in carotene (green color), usually result in good-flavored milk.

Some feeds, however, and many weeds, have a detrimental effect on flavor. Wild onions, wild garlic, and ragweeds have such pronounced effects that the milk may be unsalable. Green rye, corn or legume silage, potatoes, buckwheat, rape pasture, cabbage, and sweet clover also tend to give undesirable flavor to milk, particularly if the cows have access to them within 6 to 8 hours before milking. If any of these feeds are used, they should be given to the cows *just after milking* rather than just before.

What Plants and Trees Are Harmful?

Acorns, hedge apples, or hedge balls, persimmons, and the seeds of nearly all sweet sorghums contain substances (tannic acid or compounds similar to tannic acid) which have a strong astringent effect on the digestive system and cause milk yields to fall off rapidly and cows to go dry prematurely.

Certain weeds, such as white snakeroot, nightshade, cocklebur, water hemlock, jimson weed, dwarf larkspur, and

a number of others, are poisonous to cattle. Poisonous trees include the wild cherry, black locust, and buckeye.

FEEDING VALUE OF INDIVIDUAL FEEDS

Alfalfa hay. Probably the best dry roughage for dairy cows. Superior to most other hays in palatability, protein, lime, and vitamins. If of high quality, can be used satisfactorily as the only roughage for winter feeding.

Red-clover hay. Excellent for dairy cattle if of good quality. Superior to alfalfa for young calves. For best quality should be cut when not more than one-third of blossoms are brown.

Soybean hay. Ranks close to alfalfa in protein and lime. Finer portions high in palatability. Coarse stems, very low in feeding value and comprising 10 to 20 percent of the hay, are usually refused by dairy cows. When having fairly well matured beans, soybean hay tends to dull the appetite if fed in large quantities. With such hay as the main roughage, soybean seed should not be used in the grain mixture. Best results obtained when red-clover or alfalfa hay is fed liberally once a day and the soybean hay is fed at other times.

Cowpea hay. When containing seed, ranks high as a dairy feed. Rich in protein and lime, and very palatable. Quality often poor, however, because of difficulty in curing.

Korean lespedeza. Harvested at the early bloom stage, yields a very leafy, fine-stemmed hay which compares favorably with alfalfa of equal grade. Higher proportion of leaves than alfalfa, but lower in protein, fiber, and lime. Dairy cattle relish it after they become accustomed to it.

Timothy. Not a good feed for dairy cows if harvested at a mature stage. Low in protein and lime. Constipating. Grain mixtures needed with it are much more expensive than those needed with legume hays. Timothy harvested *considerably before blooming* is higher in protein and not so constipating, tho low in lime.

Corn silage. One of the best roughages for milk production. Very low in protein and lime, and therefore best

fed with legume hay. More nutrients per pound of dry matter than good-quality hay. Stimulates appetite, fulfilling many of the same functions in winter that fresh grass does in summer. When moldy sometimes causes serious illness.

Grass and legume silages. Usually 10 to 20 percent lower in digestible nutrients than corn silage, but higher in protein. Should be fed more liberally than corn silage, or the other feeds should be fed more liberally with it than with corn silage. Percentage of protein in grain mixture may be lowered 1 to 2 points when grass or legume silage is fed liberally.

Sorghum silage. Similar to corn silage in protein content, but furnishes only 75 to 80 percent as much digestible nutrients per ton.

Corn stover. Relatively poor roughage for dairy cows, even as compared with timothy hay. Low in protein and total digestible matter. Loses rapidly in feeding value if left in shocks in the field, because rains leach away valuable nutrients.

Ground soybean seed. A good protein supplement in grain mixtures, practically equal pound for pound to linseed meal, provided the roughage does not consist largely of soybean hay. Has a laxative effect desirable in grain mixtures fed with nonlegume hay. A large proportion of ground soybeans (not soybean oilmeal) in the grain mixture may give a gummy consistency to the butter produced, tho the flavor is not adversely affected.

Protein feeds. Cottonseed meal, corn gluten feed and meal, linseed meal, soybean oilmeal, soybean seed, and wheat bran are excellent feeds and are usually economical sources of protein. As a rule, the use of one or more of these feeds in grain mixtures for dairy cattle is profitable.

Farm grains. The cereal grains (corn and oats especially, but also barley and wheat) are excellent feeds for milk production, and when fed on the farm where grown, usually form the most economical basis for a good grain mixture.

These grains are low in protein, however, and in most cases must be combined with other feeds higher in protein. Usually it is economical to grind these grains for dairy feeds, since digestibility is increased 15 to 20 percent thereby.

FEED VALUE YIELDED PER ACRE BY VARIOUS ILLINOIS CROPS
(Based on estimated yields and average analyses)

Crop	Yield of crop per acre	Digestible protein	Total digestible nutrients
	bu. (*ton*)	*lb.*	*lb.*
Barley			
Grain	50	216	1 896
Straw[1]	(1.5)	...	.....
Total	...	216	1 896
Corn			
Grain, grade No. 3	50	196	2 240
Stover[2]	(2)	27	507
Total	...	223	2 747
Corn silage[3]	(10)	180	3 600
Oats			
Grain	50	160	1 120
Straw[1]	(1.5)	...	.....
Total	...	160	1 120
Soybeans			
Seed	25	480	1 440
Straw[1]	(1)	...	.....
Total	...	480	1 440
Hay			
Alfalfa	(3)	600	3 060
Cowpea	(1.5)	330	1 230
Lespedeza	(1)	180	1 040
Red clover	(1.5)	240	1 590
Redtop	(1.5)	150	1 590
Soybean	(2)	360	1 680
Timothy	(1.5)	90	1 470

[1]Seldom fed to cows in milk, because of low digestible matter. Quantities of total digestible nutrients are therefore disregarded.

[2]Harvesting losses and refused portions of feed taken into account. Figures given here are therefore only about one-third of the feeding value of stalks, blades, and husks if all were saved and consumed.

[3]Spoilage taken into account.

NUTRIENTS IN 100 POUNDS OF VARIOUS DAIRY FEEDS

Feed	Total dry matter	Total protein	Digestible protein	Total digestible nutrients
Concentrates	*lb.*	*lb.*	*lb.*	*lb.*
Barley	90	11	9	79
Beet pulp, dried	90	9	5	70
Brewers' dried grains	90	25	20	64
Coconut meal or cake, old process	90	21	19	79
Corn, shelled, grade No. 3	85	9	7	80
Corn-and-cob meal	85	8	6	64
Corn gluten feed	90	23	20	77
Corn gluten meal	90	40	34	80
Cottonseed meal, 43% protein	90	43	34	74
Cottonseed meal, 41% protein	90	41	33	72
Cowpea seed	90	24	20	78
Distillers' dried grains (from corn)	90	30	21	82
Hominy feed	90	10	7	85
Linseed meal, 37% protein	90	37	32	76
Linseed meal, 34% protein	90	34	30	77
Molasses, cane, or blackstrap	75	3	1	57
Oats	90	12	9	70
Peanut oilmeal, high grade	90	41	36	79
Rye	90	12	10	80
Soybean oilmeal	90	41	37	81
Soybean seed	90	37	33	86
Wheat	90	12	9	80
Wheat bran	90	15	13	70
Wheat middlings, standard	90	17	14	78
Milk				
Whole milk (cow's)	13	4	4	16
Skimmilk	10	4	4	9
Skimmilk, dried	95	35	33	84
Roughages				
Alfalfa hay	90	15	10	50
Alfalfa leaves	90	21	16	58
Alfalfa silage	28	5	3	15
Bluegrass hay	90	8	5	54
Clover, alsike, hay	90	12	8	49
Clover, red, hay	90	12	7	53
Clover, sweet, hay	90	14	6	30
Corn fodder, dry (with ears)	90	7	3	44
Corn fodder, green (with ears)	23	2	1	16
Corn silage	30	2	1	20
Corn stover, dry (without ears)	90	6	2	38
Cowpea hay	90	19	11	41
Cowpea straw	90	7	2	26
Lespedeza hay	90	13	9	52
Lespedeza straw	90	7	4	40
Oat hay	90	8	5	47
Redtop hay	90	7	4	53
Sorgo silage	25	2	1	15
Soybean hay	90	14	9	42
Soybean silage	30	4	2	16
Soybean straw	90	4	0	24
Timothy hay	90	6	3	48
Roots, etc.				
Beet, common	13	2	1	10
Mangel	9	1	1	7
Pumpkin, field	10	2	1	9

Printed in furtherance of the Agricultural Extension Act approved by Congress May 8, 1914. H. P. Rusk, *Director,* Extension Service in Agriculture and Home Economics, University of Illinois

WHAT KINDS OF FEEDS, in what proportions, will bring the most profitable returns from the dairy herd? These are the questions this circular undertakes to answer.

The recommendations are based on two assumptions: (1) that a dairy cow is primarily a roughage-consuming animal, hence that grain feeds, tho essential, should be regarded as supplements; and (2) that home-grown feeds should form as large a part of the ration as is consistent with proper protein balance.

Dairy feeding based on these principles is likely to be practical, economical, and sound.

12M—2-40—18207